WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

SOUTH CENTRAL WASHINGTON REGIONAL INTELLIGENT TRANSPORTATION SYSTEMS ARCHITECTURE

FINAL REPORT

Prepared by

IBI GROUP

September 6, 2002

1. INTRODUCTION

1.1 OVERVIEW

The State of Washington has long been a leader in the deployment of Intelligent Transportation Systems (ITS) both statewide and locally. The purpose of the Regional ITS Architecture documented in this report is to provide a framework to guide future ITS deployments within the Washington State Department of Transportation's (WSDOT) South Central Region. The Regional ITS Architecture provides guidelines for interagency communication, standards compliance, and ITS components.

The defining resource for providing guidance to state and local jurisdictions regarding ITS projects is the National ITS Architecture. This resource was developed for the U.S. Department of Transportation (US DOT) to serve as a common framework for planning, defining, and integrating intelligent transportation systems. Final Regulations issued by the U.S. Department of Transportation[1] require the development of a Regional ITS Architecture to serve as a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects. All projects that use federal highway trust funds are subject to this requirement. Thus, the Regional ITS Architecture and individual ITS projects must conform to the National ITS Architecture.

1.2 PROCESS FOR DEVELOPMENT OF THE SOUTH CENTRAL REGION ITS ARCHITECTURE

The process employed for the development of the South Central Region (SCR) ITS Architecture is depicted in Figure 1-1. The effort builds upon an inventory of existing and planned ITS deployments both regionally and statewide (upper left hand corner of Figure 1-1). These projects provide a baseline for future deployments and identify ITS Architecture elements that must be accommodated by the South Central ITS Architecture. Through inventorying ITS initiatives affecting the region and soliciting stakeholder feedback, an operational concept can be developed as part of the Regional Architecture. The Operational Concept, covered in Section 3.6, provides a blueprint for interagency cooperation and sharing of data, equipment, and overall operational coordination.

Significant existing ITS deployments in the South Central Region include traveler information systems, traffic monitoring, and Road Weather Information Systems (RWIS) for weather monitoring. Planned efforts include work zone safety, regional traffic control, and expanded traveler information. Existing and planned regional deployments will be discussed more thoroughly in Section 3. The SCR ITS Architecture was developed to capture these existing and planned efforts and provide guidance for the integration of these ITS applications. The process also analyzed potential future ITS deployments through a stakeholder review and identification of ITS market packages that best fit the needs and requirements of the Region. In the National ITS Architecture, market packages provide an accessible, deployment-oriented perspective to the national architecture. They are tailored to fit - separately or in combination - real world transportation problems and needs.[2] The market packages also include a

[1] January 8, 2001, U.S. Department of Transportation, Federal Highway Administration, 23 CFR Part 940, FHWA Docket No. FHWA-99-5899 (http://www.its.dot.gov/aconform/archrule_final_1.htm)

[2] US DOT, National ITS Architecture, Version 4.0

depiction relationship and data flow between different entities providing the "service" provided by the deployment of the market package.

To develop the South Central ITS Architecture, the following tasks were undertaken:

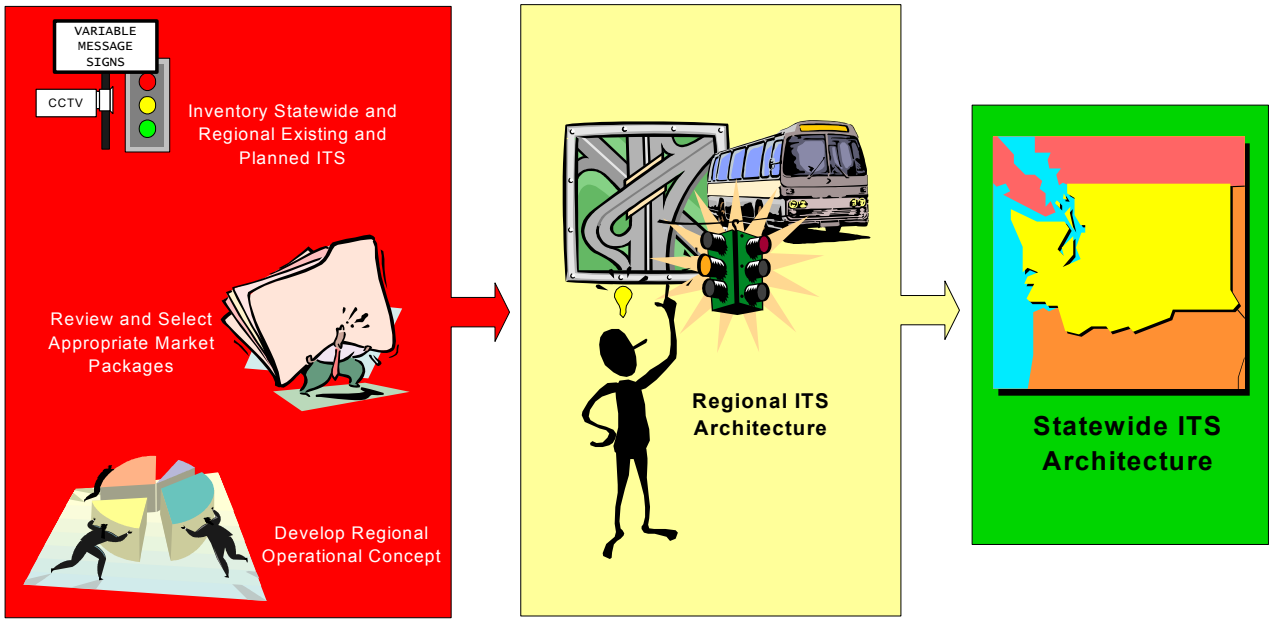
- **Document Review and ITS Inventory**: Existing planning documents for the region, provided by WSDOT, were reviewed and a general inventory of existing and planned ITS deployments was compiled.
- **Meeting with Stakeholders**: Transportation and safety representatives from local agencies were invited to a meeting where the National Architecture concepts were presented and input was sought regarding current and planned information-sharing practices and ITS deployments.
- **Market Package Selection**: At the stakeholder meeting, the attendees were guided through the list of National Architecture market packages and asked to select those that were appropriate for the region.
- **Develop Regional Operational Concept**: The Operational Concept outlines the relationships between transportation and safety agencies in the South Central Region and beyond, and how information and ITS devices are controlled and exchanged.

Together the results of these analyses were used to develop the WSDOT South Central Region ITS Architecture documented in this report. Regional Architectures have been developed, or are in the process of development, for most areas of Washington State. The final vision is to compile all existing Washington regional architectures into a statewide architecture.[3]

Figure 1.1 illustrates the regional architecture development process.

[3] A statewide communications plan is also under development as a parallel effort.

Figure 1-1: Regional ITS Architecture Development Process



1.3 ORGANIZATION OF THE REPORT

Following this introduction, this report is divided into six sections as follows:

Section 2 – Introduction to the National Architecture: This section provides information on the context of ITS Architecture development.

Section 3 – Background and Operational Concept: This section provides an overview of the South Central region and the state of ITS operations, as described in the following subsections:

- Description of Region: Provides an overview of the South Central Region's characteristics affecting transportation in the area.
- Identification of Stakeholders: Lists the stakeholders identified and contacted for feedback as part of this project.
- Existing and Planned Activities: Washington ITS projects and deployments affecting the region.
- Operational Concept: Outlines communications both electronic and manual between agencies.

Section 4 - Agreements: Considerations for interagency cooperative agreements.

Section 5 - System Functional Requirements, Interface Requirements, and Information Exchanges: Introduction to the approach of developing a regional ITS architecture diagram from a WSDOT perspective, and detailed description of the elements included in the diagram.

Section 6 - Identification of ITS Standards: Introduction to the standards development effort and identification of standards likely to affect the SCR based on the selected Market Packages.

Section 7 - Sequence of Projects Required for Implementation: Identifies any projects that must have precedence over others in order to implement the overall ITS vision for the region.

2. NATIONAL ITS ARCHITECTURE INTRODUCTION

This section provides background information on the National ITS Architecture, and the final FHWA rulemaking regarding the development of Regional ITS Architecture.

The National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. It is a mature product that reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, etc.). The architecture defines:

- The functions (e.g., gather traffic information or request a route) that are required for ITS.
- The physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle).
- The information flows that connect these functions and physical subsystems together into an integrated system.[4]

Although the architecture is not technology-specific, it is function-specific. The architecture is employed to structure the planning and design process along with the general functions of ITS systems. The architecture further defines these functions into two categories: physical and logical.

2.1.1 Physical Architecture

The physical architecture provides a framework for the physical elements of ITS systems. These elements include cars, people, computers, buses, trucks, etc. Figure 2-1, National ITS Architecture Subsystems, provides an illustration of the physical architecture. The physical elements are broken into large groups called **subsystem categories**. These are functional categories that describe what their member physical entities (subsystems) do.

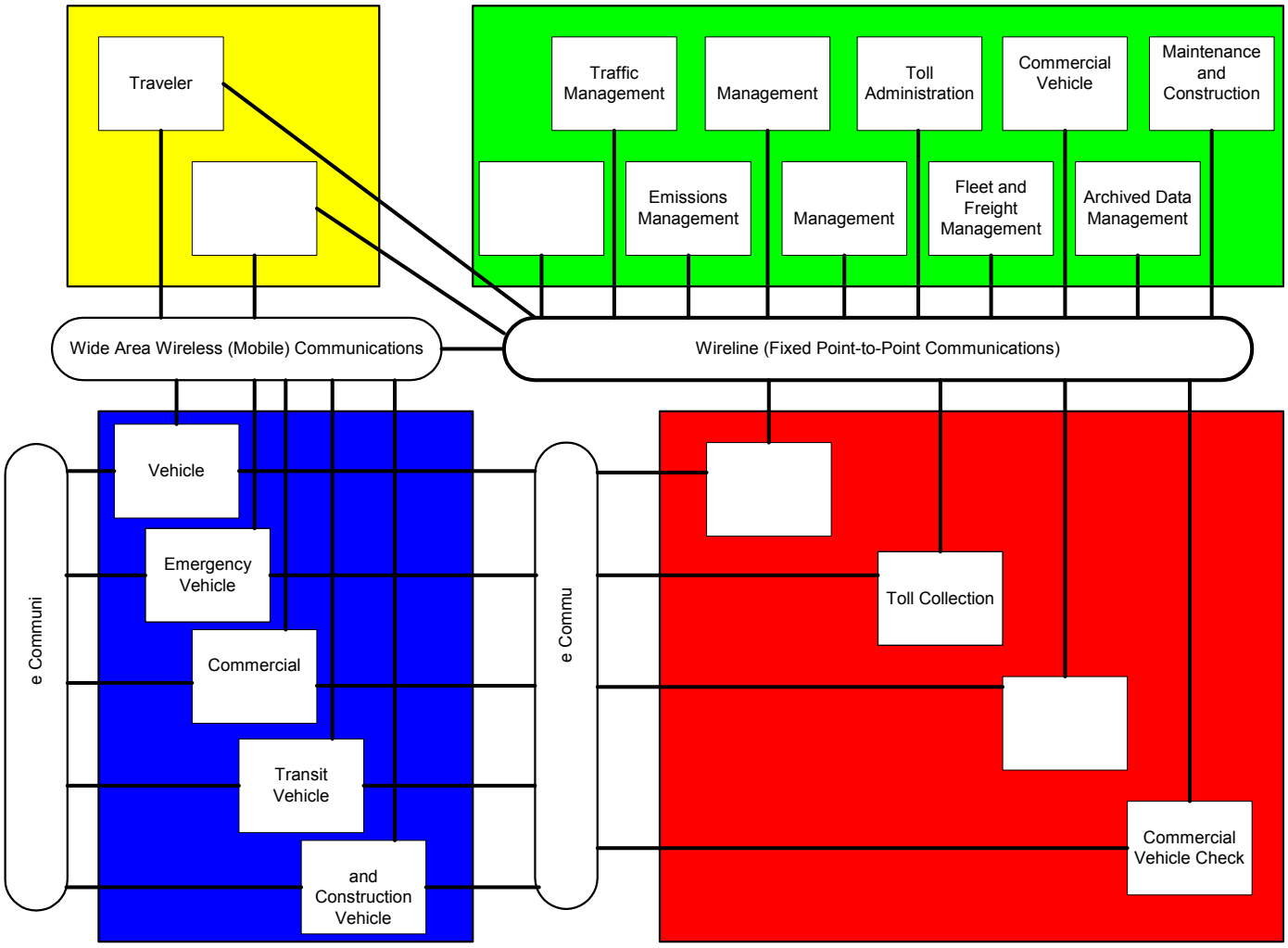
The four major subsystem categories are:

1. **Traveler Subsystems**: Systems or applications that provide information to travelers (e.g., traffic conditions).
2. **Center Subsystems**: Systems or applications that process and use information to control the transportation network (e.g., signal timing).
3. **Vehicle Subsystems**: Systems or applications that provide driver information and safety on vehicle platforms (e.g., in-vehicle signing).
4. **Roadside Subsystems**: Systems or applications that process and provide vehicle system data (e.g., traffic signals).

The bubbles (or sausages) between the subsystem categories represent the communications medium. For example, the Roadway subsystem (within the "Roadside" subsystem category) could potentially be communicating with the Vehicle, the Transit Vehicle, the Commercial Vehicle, and the Emergency Vehicle subsystems (within the "Vehicle" subsystem category) via short-range wireless links.

[4] US DOT, National ITS Architecture, Version 4.0

Figure 2.1. National Architecture Subsystems



2.1.2 Architecture Flows

An architecture flow is simply the information that is exchanged between subsystems and terminators in the Physical Architecture. Each architecture flow contains one or more data flows from the Logical Architecture. These architecture flows and their communication requirements define the interfaces which form the basis for much of the ongoing standards work in the National ITS Architecture program. The current US DOT guidelines require that the ITS Architecture be developed at a sufficient level of detail to show subsystems and architecture flows.

2.1.3 Terminators

Terminators are generally defined as people, systems and general environment that are outside the boundary of ITS but still impacting ITS systems. Interfaces between subsystems and terminators need to be defined, but there are no ITS-related functional requirements associated with terminators. Since regional architectures are usually developed from a specific agency(s) perspective, a subsystem that is

out of the control of the entity's perspective is called a terminator. This is done to illustrate ownership/control of the proposed services.

2.1.4 Market Packages

While the physical architecture components, such as subsystems and architecture flows, provide a good tool for organizing the ITS design process, they are difficult to discuss with anyone who is not familiar with the National ITS Architecture. The Market Packages provide an accessible, deployment-oriented perspective to the National Architecture. They are tailored to fit - separately or in combination - real world transportation problems and needs. Market Packages utilize one or more Equipment Packages that must work together to deliver a given transportation service and the architecture flows that connect them and other important external systems. In other words, they identify the pieces of the Physical Architecture that are required to implement a particular transportation service. Equipment Packages group like processes of a particular subsystem together into an "implementable" package. The Market Packages also help in the design process by categorizing improvements and can serve as another check to make sure areas are not over or under covered.

For example, the Market Package "Regional Traffic Control" is made up of the subsystems "Traffic Management" and "Roadway", as well as the terminator "Other TM" (see Figure 2-2 on the following page). The service to be provided is regional traffic control. In order to do this, the entity must have control or access to processes under traffic management and roadway. The specific process needed is "TMC Regional Traffic Control." This Equipment Package provides capabilities for analyzing, controlling, and optimizing area-wide traffic flow. These capabilities provide for wide area optimization integrating control of a network signal system with control of freeway, considering current demand as well as expected demand with a goal of providing the capability for real-time traffic adaptive control while balancing inter-jurisdictional control issues to achieve regional solutions. The terminator "Other TM" shows that the information collected must be accessible by other traffic management centers. The architecture flow indicates that "traffic information coordination" and "traffic control coordination" will be exchanged between the "Traffic Management" subsystem and "Other TM" terminator.

Architecture flows represent the information flows between subsystems and terminators. These flows can be broken down further into data-flows and process specifications. This breakdown defines more and more detailed information exchanges between the subsystems and terminators. This level of detail becomes more useful in the project design and implementation stages.

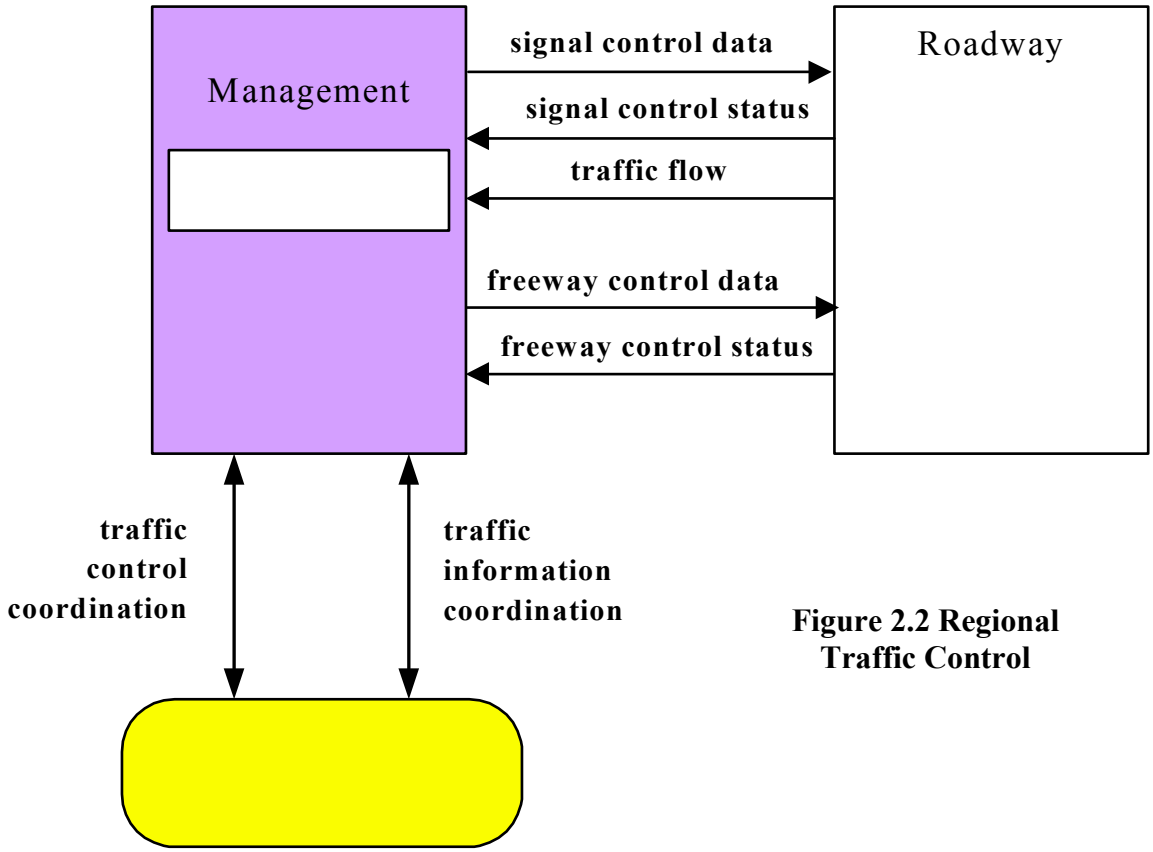


Figure 2.2 Regional Traffic Control

2.2 FEDERAL HIGHWAY ADMINISTRATION REGULATIONS

FHWA has issued a final rulemaking to implement section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21). This section required ITS projects funded through the highway trust fund to conform to the National ITS Architecture and applicable standards. Conformance with the National ITS Architecture is defined as development of a Regional ITS Architecture and the subsequent adherence of ITS projects to the Regional ITS Architecture. The Regional ITS Architecture is based on the National ITS Architecture and consists of several parts including the system functional requirements and information exchanges with planned and existing systems and subsystems along with identification of applicable standards. The Regional ITS Architecture would be tailored to address the local situation and ITS investment needs[5]. The rule became effective on April 8, 2001.

The purpose of the Regional ITS Architecture is to serve as a guide for the development of ITS projects and programs and be consistent with ITS strategies and projects contained in applicable transportation plans. Having developed a Regional ITS Architecture means that a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects is in place.

[5] January 8, 2001, U.S. Department of Transportation, Federal Highway Administration, 23 CFR Part 940, FHWA Docket No. FHWA-99-5899 (http://www.its.dot.gov/aconform/archrule_final_1.htm)

As mentioned earlier, the Regional ITS Architecture must include the following elements:

- Description of the Region or Project
- Identification of Stakeholders
- Operational Concept
- Agreements
- System Functional Requirements
- Interface Requirements and Information Exchanges
- Identification of ITS Standards
- Sequence of Projects Required for Implementation[6]

The size of the region should reflect the breadth of the integrations effort and is left to the discretion of the cooperating organizations.

2.3 IMPLICATIONS

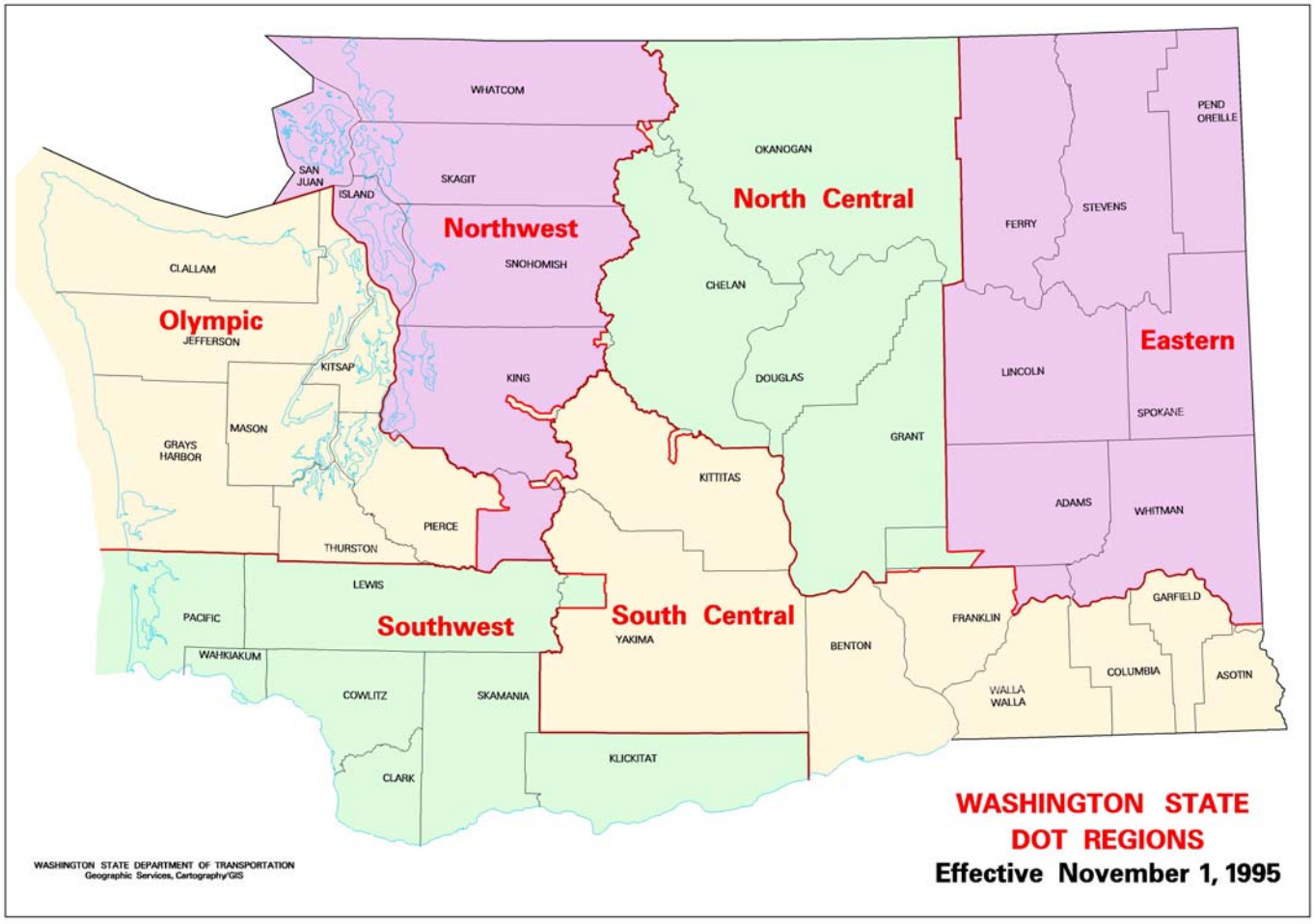
The final rule making by FHWA provides the guidance for the development of Regional ITS Architectures. The individual ITS projects that exist or are planned for the region must all be integrated into an overall ITS Architecture. The architecture will provide the technical and institutional framework for incorporating planned projects into a larger vision for the South Central Region and the rest of the state.

[6] January 8, 2001, U.S. Department of Transportation, Federal Highway Administration, 23 CFR Part 940, FHWA Docket No. FHWA-99-5899 (http://www.its.dot.gov/aconform/archrule_final_1.htm)

3. REGIONAL BACKGROUND AND OPERATIONAL CONCEPT

The statewide and regional existing and planned ITS deployments, along with a few "wish list" projects mentioned by stakeholders provide the baseline for development of the Regional Architecture. The Regional Architecture is a customized subset of the National Architecture, which provides an institutional and technical framework for the deployment of ITS applications. This section builds on existing and planned ITS projects discussed below to develop the SCR ITS Architecture.

3.1 DESCRIPTION OF THE REGION



WSDOT Regions[7]

The South Central Region consists of ten counties: Asotin, Garfield, Columbia, Walla Walla, Franklin, Benton, Yakima, Kittitas, and parts of King and Whitman. Yakima, Ellensburg, and the Tri-Cities are the most densely populated areas. Snoqualmie Pass along I-90 is considered a key link between Western and Eastern Washington, and is closely monitored in winter for changing conditions, avalanche potential, and incidents.

[7] Source: WSDOT

3.2 IDENTIFICATION OF STAKEHOLDERS

Stakeholders provide crucial input regarding an area's transportation characteristics, ITS deployments, and future needs. Stakeholders are generally considered to be those who own, operate or use ITS. For this project, a meeting was held with representative from the following agencies:

- WSDOT South Central Region
- WSDOT Headquarters
- City of Kennewick
- Walla Walla County
- City of Ellensburg
- City of Richland
- Ben Franklin Transit
- Yakima Valley Council of Governments
- Benton-Franklin Council of Governments
- Benton County
- Washington State Patrol (WSP)
- Yakima Transit
- Yakima County
- City of Yakima
- City of Pasco
- Franklin County

Other stakeholders are considered to be emergency service providers, other cities and towns in the region, and local law enforcement.

3.3 STATEWIDE ITS DEPLOYMENTS AFFECTING THE SOUTH CENTRAL REGION

The following projects are WSDOT-sponsored statewide initiatives that may impact the SCR ITS Architecture in terms of data and systems that may become available to that region.

3.3.1 rWeather

The WSDOT rWeather (road-Weather/"Our" weather) project collects and disseminates real-time and predictive statewide road and weather information. The program gathers data from a variety of sources and provides statewide weather and road-condition reports and forecasts.[8] Available information includes incidents, construction, mountain pass conditions, video, and audio highway advisory radio messages.

3.3.2 Condition Acquisition and Reporting System (CARS)

CARS is a Internet-based application for entering incident information for incidents occurring statewide on interstates, US highways, and state routes. At this time, the CARS mapping system does not include the county and city roads that would make it of use to regional/local agencies. However, WSDOT is

[8] WSDOT rWeather web site: http://www.wsdot.wa.gov/rweather/

considering a trial local deployment whereby the system would be expanded to include one county's local roads.

3.3.3 511 System[9]

On July 21, 2000 the Federal Communications Commission designated 511 as the national traveler information number. Washington's statewide 511 system will condense the numerous traveler information numbers available in Washington to the single 3-digit code. As of July 2002, six states have active 511 programs. The WSDOT 511 system is nearing rollout at this time.

3.3.4 Commercial Vehicle Information Systems and Networks (CVISN)

The CVISN program uses ITS technology to promote the safe and legal movement of commercial vehicle traffic within Washington and across the nation. CVISN is a cooperative effort among the following agencies:[10]

- Washington State Patrol
- Washington State Department of Licensing
- Washington Trucking Associations
- Washington State Department of Transportation
- Federal Motor Carrier Safety Administration

As the South Central Region experiences significant truck traffic along I-90 and I-82, it is expected that the CVISN program is likely to have an impact (in terms of deployed equipment and programs) on the area's roadways.

3.3.5 Washington State Patrol CAD Upgrade

The WSP will be acquiring an updated computer aided dispatch (CAD) system within a short time. This will enable improved response times and better communication between dispatch and vehicles. This new system will include the ability to electronically share information on incidents and activities between WSP and WSDOT. WSDOT will further distribute this information to the general public over the Internet, 511, and other dissemination methods.

3.3.6 WSDOT Traffic and Weather Site[11]

WSDOT's weather and road condition site compiles camera images, weather forecasts and mountain pass reports covering the entire state, as well as a link to the Puget Sound traffic flow map. This multi-purpose site provides pre-trip traveler information to the general public while also being a resource to maintenance workers needing access to real-time weather information for their districts.

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[9] 511 information from the US DOT: http://www.its.dot.gov/511/511.htm

[10] WSDOT CVISN web site: http://cvisn.wsdot.wa.gov/

[11] http://wsdot.wa.gov/traffic/default.htm

3.4 SCR EXISTING ITS DEPLOYMENTS

Existing ITS infrastructure in the South Central region includes roadside, traffic control, environmental management, transit devices, and the Transportation Management Center (TMC).

3.4.1 Central Washington Transportation Management Center (TMC

The TMC, located at the Washington State Patrol (WSP) building in Union Gap, provides 24-hour traffic and roadway condition monitoring of selected roadways in both the South Central and North Central regions. The TMC also provides the critical function of immediate communication response to any situation affecting traffic in either region. In addition to controlling all roadside ITS devices, TMC staff both receive and disseminate reports of inclement weather, incidents, congestion, and other transportation-impacting alerts.

3.4.2 Roadside

Roadside technologies currently deployed in the South Central Region include:

- Dynamic Message Signs (DMS) for traveler information and variable speed limits
- Highway Advisory Radio (HAR)
- Road Weather Information Systems (RWIS) sensors
- CCTV Cameras
- Loop Traffic Recorders
- Radar Vehicle Detectors

3.4.3 Traffic Control

The City of Yakima has forty Peek video detection devices and uses the advanced 9800 signal controllers to manage their 88 intersections. Since 1999, the city has had an ongoing signal optimization project to improve signal timing and efficiency. For regional signal control, WSDOT uses time-based and master systems. Signal coordination efforts are underway on Yakima Avenue and Nob Hill Boulevard (SR 24) to improve flow onto I-82.

3.4.4 Environmental Management

Yakima is coordinating an air quality alert system that would use RWIS equipment to sense poor air quality. This information would then be used to encourage travelers to consider alternate routes.

3.4.5 Transit Management

Ben Franklin Transit (serving the Tri-City area) uses infrared based (Opticom) transit signal priority and Computer Aided Dispatch (CAD) for their Dial-A-Ride service routing and dispatch. This agency also has a transit information web site with routes and schedules posted. Yakima Transit has surveillance cameras installed on buses and at transfer points.

3.4.6 Incident Response Management

As a result of successful incident response patrols in the Puget Sound region, WSDOT is expanding this effort statewide. In the South Central Region, two units patrol Snoqualmie Pass on weekends and holidays. Incident response teams provide traffic control, traffic rerouting, mobile communications, and assistance in incident clearance and clean up.[12]

3.5 SCR PLANNED ITS DEPLOYMENTS

A variety of ITS projects are in the planning stages for potential future deployment. However, it should be noted that **not all of these projects have been formally approved**. These projects include:

3.6 DMS AND HAR EXPANSIONS

New DMS are to be deployed at various locations, including Snoqualmie Pass, I-90 near I-82, I-82 near Yakima, US 97 at Status Pass, SR 12 between Pomeroy and Clarkston (Alpowa Summit), and I-90 at the West Slope Cascades. HAR will be added at I-82 near Yakima. All of these devices will be controlled via the Central Washington TMC.

3.6.1 "Travel Aid" Upgrade

"Travel Aid" is a successfully deployed program that uses DMS to vary the speed limit along stretches of I-90 in response to weather conditions. Software and computer upgrades will be developed for the Snoqualmie Pass Traveler Information and Variable Speed Limit system.

3.6.2 US 395 Columbia River Bridge Traffic Operations

A need has been expressed for CCTV, HAR, DMS, traffic volume detectors and communications to be deployed over the Blue Bridge in Pasco.

3.6.3 Tri-Cities Advanced Traffic Management

As a result of increasing congestion in the Tri-Cities area, there may be a need for advanced traffic management capabilities for the purpose of coordinating traffic signal operations with WSDOT and Benton/Franklin counties. CCTV, traffic detectors, and flow maps may also be deployed as part of this effort. Devices deployed over the Blue Bridge and in other areas could then potentially be controlled locally.

3.6.4 Adverse Weather Operations Improvements

This project will install road surface temperature probes, weather monitoring stations, stream monitors, and other advanced technology components to improve the efficiency of winter maintenance operations. This project has received funding.

[12] Source: WSDOT

3.6.5 Work Zone Traffic Safety System

This project will develop and deploy a reusable and portable traffic management and traveler information system. The system will initially be used on I-90 in the Snoqualmie Pass area. This project has been funded.

3.7 OPERATIONAL CONCEPT

The operational concept portion of the SCR ITS Architecture defines the institutional relationships among the organizations in the region required for the deployment and operation of a regional integrated transportation management and information system. The operational concept establishes the roles and responsibilities between organizations including responsibilities for operation and maintenance and the level of information, status, and control sharing among the entities.

In the National ITS Architecture, market packages include a depiction relationship and data flow between different entities providing the "service" provided by the deployment of the market package. For example, the incident management system market package requires that traffic management and emergency management centers exchange information. This implies that an operational concept and an institutional relationship be established between the two organizations that are cooperating. The identification of which market packages are and will be deployed in the SCR leads the way to define an operational concept for the Regional ITS Architecture.

Table 3-1 shows all of the market packages that are encompassed by the SCR ITS Architecture. The market packages are listed by organization. The selection of market packages is based upon existing and planned ITS projects and on consultation with regional stakeholders on potential future ITS applications.

Table 3-1: South Central Region Market Packages by Stakeholder

Market Package	WSDOT Headquarters	WSDOT Central Region	Washington State Patrol	Local Traffic Operators	Transit/ Paratransit Providers
		√		√	
ITS Data Warehouse	√				
Demand Response Transit Operations					√
Transit Security					√
Multi-Modal Coordination		√		√	√
Transit Traveler Information					√

Market Package	WSDOT	WSDOT South Region	Washington Patrol	Local Operators	Transit/ Providers
Broadcast Traveler Information	√	√		√	
Interactive Traveler Information	√	√		√	
Network Surveillance	√	√		√	
Surface Street Control		√		√	
Dissemination	√	√		√	
Regional Traffic Control		√		√	
Incident Management System		√	√	√	
Emergency Response		√	√		
Emergency Routing		√	√		
Roadway Service Patrols		√	√		
Maintenance and Construction Vehicle Tracki		√			
Road Weather Data		√			
Weather Information Processing and Distribution		√	√	√	√
Winter Maintenance		√			
Roadway Maintenance and Construction		√		√	
Work Zone Management		√			
afety Monitoring		√			

Market Package	WSDOT Headquarters	WSDOT South Central Region	Washington State Patrol	Local Traffic Operators	Transit/ Paratransit Providers
Maintenance and Construction Activity Coordination		√		√	

Most market packages do not require interaction with other organizations, and can be generally implemented as stand-alone applications locally. In these cases, the market package itself defines the operational concept for deployment.

However, several market packages have been identified as requiring jurisdictional interaction and the need to define regional operational concepts. These market packages are:

- Incident Management System
- Broadcast and Interactive Traveler Information
- Regional Traffic Control
- Traffic Information Dissemination
- ITS Data Mart
- Commercial Vehicle Operations (a summation of the CVO market package set)
- Maintenance and Construction Activity Coordination
- Weather Information Processing and Distribution

Each of these market packages requires an operational concept that will involve multiple jurisdictional relationships. In several cases, multiple traffic and emergency management agencies will need to form relationships with each other to define specific roles and responsibilities for the deployment of the market package.

In defining an operational concept, it is key to consider that relationships between agencies embody two main components: 1) what roles and responsibilities does each agency play in the relationship and 2) what kinds of information is shared. Eight types of roles or responsibilities have been identified to describe agency-to-agency relationships:

Table 3.2 – Operational Relationships

Relationship	Definition	"From/To" Example
Independent	Parties operate independently with no interaction.	No interaction.
Consultation	One party confers with another party, in accordance with an established process, about an anticipated action and then keeps that party informed about the actions taken. No electronic sharing of information.	activities to interested TO agencies.
Cooperation	The parties involved in carrying out the planning, project development and operations processes work together to achieve common goals or objectives. No electronic sharing of information.	Both agencies cooperate in the development and execution of common plans, projects, and operational procedures.
Information Sharing	The electronic exchange of data and device status information between parties, for the purposes of coordinated operations, planning, and analysis.	FROM agency will provide status, data, M agency's field devices (e.g., detectors) to the TO agency.
Control Sharing	The ability, through operational agreements, to allow for one party to control another party's field devices to properly respond to incident, event, weather, or traffic conditions.	FROM agency is allowed by the TO devices (e.g., DMS, select signal timing patterns) for specified defined occurrences.
Only Operational Responsibility Shifted	One party operates the field equipment of a second party on a full time basis.	FROM agency will operate the field devices of the TO agency (e.g., County operates a City's traffic signals but the City is responsible for maintenance and repairs).
Only Maintenance Responsibility Shifted	One party maintains the field equipment of a second party.	FROM agency maintains the field devices of the TO agency, but the TO agency is responsible for operations.
Full Responsibility Shifted	One party has full responsibility for the field equipment of a second party including operations and preventative and emergency maintenance.	FROM agency operates and maintains the field devices of the TO agency.

Along with these eight roles and responsibilities are associated information types that are typical for agency-agency exchange. Five primary types of information exchanges were identified:

Table 3.3 – Information Exchanges

Information Flows	Definition	"To/From" Example
Data	The dissemination of data gathered from one party's field devices to a weather, parking, transit data etc.	the TO agency's field devices.
Video	The field	FROM agency sends live video and still images to the TO agency.
Status	The ability for one party to monitor another parties field devices, and e pla	FROM agency sends status the TO agency.
Request	The m change, such as DMS messaging or signal timings, from another	FROM agency requests information or action from the
Control	The ld d Control can include but is not limited to, changing DMS messaging, changing traffic signal timings, camera control, etc.	instruction to the TO agency's field devices.

3.7.1 Incident Management System

This market package manages both predicted and unexpected incidents so that the impact to the transportation network and traveler safety is minimized. Requisite incident detection capabilities are included in the freeway control market package and through the regional coordination with other traffic management and emergency management centers, and weather service entities. Information from these diverse sources are collected and correlated by this market package to detect and verify incidents and implement an appropriate response[13]. The required relationships are presented in Table 3.4.

[13] US DOT, National ITS Architecture, Version 4.0

Table 3.4: Incident Management System – Operational Concept

FROM	TO	RELATIONSHIP	INFORMATION
Central Washington TMC	WSP	Information Sharing	Data Video Request
WSP	WSP SCR	Information Sharing	Data Request
Central Washington TMC	Tri-Cities City of Yakima	Information Sharing	Data Status
Tri-Cities City of Yakima	Central Washington TMC	Information Sharing	Data Request
Central Washington TMC	Emergency Response	Information Sharing	Data
Emergency Response	Central Washington TMC	Information Sharing	Data

3.7.2 Broadcast and Interactive Traveler Information

Broadcast Traveler Information provides users with a basic set of advanced traveler information services. It involves the collection of traffic conditions, advisories, general public transportation, parking information, incident information, and weather information, and the near real time dissemination of this information over a wide area through existing infrastructures and low cost user equipment. Interactive Traveler Information provides tailored information in response to a traveler request.[14] WSDOT's Road Condition Hotline provides information to the public regarding current incidents, roadway conditions, and construction projects affecting travel through mountain passes and other regional highways.[15] This information is updated by TMC personnel. The traffic information collected by roadside detection will eventually be used for an online flow map of I-90 and possibly I-82. The flow map will help both commuters and TMC operators monitor current conditions and detect potential incidents. Currently, CCTV images and weather information are provided via the statewide WSDOT web page. The TMC also provides travel condition data to local radio stations.

Table 3.5: Broadcast and Interactive Traveler Information – Operational Concept

FROM	TO	RELATIONSHIP	INFORMATION
WSDOT Headquarters	Remote Traveler Support Personal Info Access	Information Sharing	Data
Remote Traveler Support Personal Info Access	WSDOT Headquarters	Information Sharing	Request

[14] US DOT, National ITS Architecture, Version 4.0

[15] Source: WSDOT

FROM	TO	RELATIONSHIP	INFORMATION
Central Washington TMC	WSDOT Headquarters	Information Sharing	Video Data
WSDOT Headquarters	Central Washington TMC	Information Sharing	Request Data
Central Washington TMC	Media	Consultation	Data

3.7.3 Regional Traffic Control

Regional Traffic Control provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control market packages and adds hardware, software, and wire line communications capabilities to implement traffic management strategies which are coordinated between allied traffic management centers.[16] Regionally, WSDOT operates any signals that are along state highways or at freeway entrances. The City of Richland, City of Pasco, City of Kennewick, and City of Yakima all expressed interest in coordinating their local signals with SCR-operated signals. Currently, the City of Kennewick coordinates with WSDOT signals on US 395. Further coordination could entail several steps, from simply sharing timing plans, to sharing signal control, to fully turning over operation and maintenance of these signals to local traffic management.

Table 3.6: Regional Traffic Control – Operational Concept

FROM	TO	RELATIONSHIP	INFORMATION
City of Richland City of Pasco City of Kennewick City of Yakima	Central Washington TMC	Information Sharing	Data Request Status
Central Washington TMC	City of Richland City of Pasco City of Kennewick City of Yakima	Information Sharing Control Sharing	Data Request Control Status

3.7.4 Traffic Information Dissemination

This market package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as DMS or HAR. This package provides a tool that can be used to notify drivers of incidents; careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center

[16] US DOT, National ITS Architecture, Version 4.0

and radio or television station computer systems), Transit Management, Emergency Management, and Information Service Providers. A link to the Maintenance and Construction Management subsystem allows real time information on road/bridge closures due to maintenance and construction activities to be disseminated[17]. In the South Central Region, numerous traffic information devices (DMS and HAR) are in place, and further installations are planned. There is potential benefit from improved interstate road closure and conditions coordination with traffic management centers in Seattle, Spokane and Olympia, as well as with the Oregon Department of Transportation (ODOT). Improved coordination, and potential access to field devices, would extend the reach of localized road conditions information across the state.

Table 3.7: Traffic Information Dissemination – Operational Concept

FROM	TO	RELATIONSHIP	INFORMATION
Central Washington TMC	Other WSDOT TMC's ODOT Region 5 (Pendleton)	Information Sharing (Future)	Data
Central Washington TMC	Roadside	Operations	Control
Roadside	Central Washington TMC	Operations	Data Status
WSP	Central Washington TMC	Information Sharing	Request
Central Washington TMC	WSP	Information Sharing	Status Data
Central Washington TMC	WSDOT HQ	Information Sharing	Data Status
WSDOT HQ	Central Washington TMC	Information Sharing	Request

3.7.5 ITS Data Mart

In most regions where ITS has been deployed, there is a need to capture and archive information for future analysis and planning. The National ITS Architecture market package that supports this concept locally is the ITS Data Mart. "This market package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use."[18] Each agency has the responsibility of archiving their individual data internally, playing the role of the ITS Data Mart for their local data. In the South Central Region, the Data Mart could store traffic counts, weather data, signal timing plans, etc. This information could be made available to other agencies as needed.

[17] US DOT, National ITS Architecture, Version 4.0

[18] US DOT, National ITS Architecture, Version 4.0

3.7.6 Commercial Vehicle Operations (CVO) Applications

The Commercial Vehicle Information System Network (CVISN) is the primary CVO application in Washington State. Using ITS technologies such as vehicle tags and roadside detection, CVISN helps to expedite the safe and legal transport of freight along state roads. CVISN is a cooperative effort among the following agencies:

- Washington State Patrol
- Washington State Department of Licensing
- Washington Trucking Associations
- Washington State Department of Transportation
- Federal Motor Carrier Safety Administration

These agencies will define the operational concept for CVISN in Washington. The latest information and a list of relevant documents can be found at http://cvisn.wsdot.wa.gov.

3.7.7 Maintenance and Construction Activity Coordination

This market package allows for the collection of regional maintenance and construction event information and its dissemination to other centers and/or travelers. There is an interest in sharing this information between SCR operations and local cities.

Table 3.8: Maintenance and Construction Activity Coordination – Operational Concept

FROM	TO	RELATIONSHIP	INFORMATION
WSDOT SCR	City of Yakima City of Richland City of Kennewick City of Pasco	Information Sharing	Data Request
City of Yakima City of Richland City of Kennewick City of Pasco	WSDOT SCR	Information Sharing	Data Request

3.7.8 Weather Information Processing and Distribution

Especially because of Snoqualmie Pass, and the related winter weather conditions, the effective distribution of weather information in the South Central Region is very important. At the state level, WSDOT's rWeather site compiles Road/Weather Information System (RWIS) data from sensors deployed statewide, and also includes National Weather Service alerts. The site has recently been redesigned for improved usability and in the hopes that it will be more frequently used as a maintenance resource. Regionally, "raw" weather information can be accessed and monitored via the State's ScanWeb RWIS data site. Weather information distribution is desirable to the local cities, transit providers, Washington State Patrol, local media and local emergency service providers. Yakima County's roadside data collection devices are an additional source of information.

Table 3.9: Weather Information Processing and Distribution – Operational Concept

FROM	TO	RELATIONSHIP	INFORMATION
WSDOT Headquarters	Roadside	Information Sharing	Data Request
Roadside	WSDOT Headquarters	Information Sharing	Data Status
WSDOT Headquarters	Central Washington TMC	Information Sharing	Data
Central Washington TMC	Local Cities WSP Transit Emergency Services	Information Sharing	Data
Yakima County	Roadside	Information Sharing	Data Request
Roadside	Yakima County	Information Sharing	Data Status
Yakima County	Central Washington TMC Other Local Agencies	Information Sharing	Data

4. AGREEMENTS BETWEEN ORGANIZATIONS

The Regional ITS Architecture provides both a technical and institutional framework for the deployment of ITS in the South Central region. Institutional integration involves coordination between various agencies and jurisdictions to achieve seamless operations and/or interoperability. The existing and recommended operational concepts defined in the previous section provide guidance for the functional requirements of inter-jurisdictional interactions. These inter-jurisdictional operational concepts in turn point directly to the types of agreements that may potentially be required between individual organizations. Either informal or formal agreements are required to define the roles and responsibilities for each of these interactions. This section of the report discusses existing, planned and potential agreements in the region and a checklist for consideration in developing an agreement.

4.1 EXISTING, PLANNED AND POTENTIAL AGREEMENTS

The operational concept section of the report identified the key market packages and ITS deployment activities that would require establishment of an electronic link between and among organizations. From an institutional integration perspective, these electronic links will require the establishment of some form of agreement to define roles and responsibilities of each party.

- **Regional Traffic Control**: Potentially desirable between the Tri-Cities, Yakima and WSDOT, the complete implementation of this market package would result in the joint sharing and potential control of traffic signals, detectors, cameras, ramp meters, and dynamic message signs. Agreements that detail the limits of authority, operational discretion, and liability will be required before "joint control" would be implemented. A critical technical agreement required for interoperability will be the identification of the preferred center-to-center NTCIP standard to enable this market package.
- **Incident Management**: Agreements between transportation and emergency management organizations will need to be developed if a formal interagency incident management system is deployed.
- **511 Three-Digit Traveler Information Telephone Number**: The Federal Communications Commission (FCC) has designated 511 as the new telephone number for traveler information across the country. This number is designed to be the single telephone number for obtaining traveler information for all modes. Washington State jurisdictions have begun a cooperative process to transition the multiple transportation information numbers in the region to this one number. The planning and deployment process will span several years.
- **Data Archiving**: Movement toward an automated system of archiving data at the regional level will require the development of agreements on the format, access and use of the information.
- **Communications**: There are multiple examples and opportunities for the sharing of communications infrastructure throughout the region. The upcoming statewide communications plan and subsequent agreements that define responsibilities could result in the communications network required to link the various ITS applications together.

4.2 ELEMENTS OF AN AGREEMENT

Agreements are established to clearly define responsibilities among the involved parties. The level of formality generally increases as risks escalate and when financial transactions take place. Formality will also increase when the performance or lack of performance on the part of one organization impacts the operations of another. For example, if an agency maintains and operates the traffic signals of another agency, failure to restore a failed traffic signal in a timely fashion could have a significant impact. As different systems are linked together, they will depend upon each other. The clear definition of responsibilities for all parties will help ensure smooth operations.

The WSDOT/WSP Joint Operations Policy Statement (JOPS) is an example of a highly successfully interagency agreement. WSDOT and WSP are two statewide agencies that have mutually benefited from a joint operations agreement. For each joint operations program area, including traffic management, incident response and commercial vehicle operations, JOPS defines an overall policy, the role of each agency, references to other existing documented policies, and future action. A detailed description of each agency's role in Washington is given, along with contact information for key personnel contacts.

The following is an annotated checklist of elements to consider in the development of an agreement for ITS operations and maintenance. Not all elements are relevant to exchange of information. The level of specificity will depend on the nature of the information link. This list is provides as a starting point for considering interagency cooperative agreements for device control sharing, information sharing or transfer of device ownership.

- Operational Concept (A layman's introduction to the nature and purpose of the agreement.)
- Duties of Responsible Organizations (A summary of duties and responsibilities.)
- Data Sharing (Aspects of sharing data to be considered.)
  - Provision of Data
  - Data Rights
  - Data Reuse
  - Data Identification
  - Data Availability
  - Data Accuracy
- Control Sharing (Aspects of sharing control to be considered with rights and priorities being clearly understood.)
  - Provision of Control
  - Control Rights
  - Control Restrictions
  - Control Priority
  - Control Availability
- Connections (Defines how the connection is made.)
  - Provision of Equipment
  - Physical Access Point
  - Demarcation Point
  - Security
  - Configuration Management

  - Standards and Protocols
- System Documentation
- Operations
  - Contacts
  - Hours of Operations
  - Responsibilities
- Maintenance
  - Contacts
  - Hours of Operations
  - Responsibilities
  - Response Time
- Liability
  - Indemnity
  - Damage to Equipment
  - Liability
- Ownership
  - Equipment
  - Software
  - Intellectual Property
- Coordination
  - Notification
  - Periodic Reporting
  - Pre-Change Coordination Meeting
- Dispute Resolution
- Termination of Agreement
- Compensation

In Washington State, there is a long history of formal and informal inter-agency agreements. The majority of formal agreements involve the transfer of funds from one organization to another and have generally involved transportation construction projects. However, there are still a wide number of existing agreements that address operations and maintenance, which can serve as models. In the Puget Sound region, King County and Community Transit have developed agreements for the installation, operation, and maintenance of transit signal priority equipment. Several jurisdictions (e.g., King County, the City of Lynnwood, Snohomish County) operate and maintain signals for other jurisdictions. These agreements touch all of the issues listed above.

5. SYSTEM FUNCTIONAL REQUIREMENTS, INTERFACE REQUIREMENTS AND INFORMATION EXCHANGES

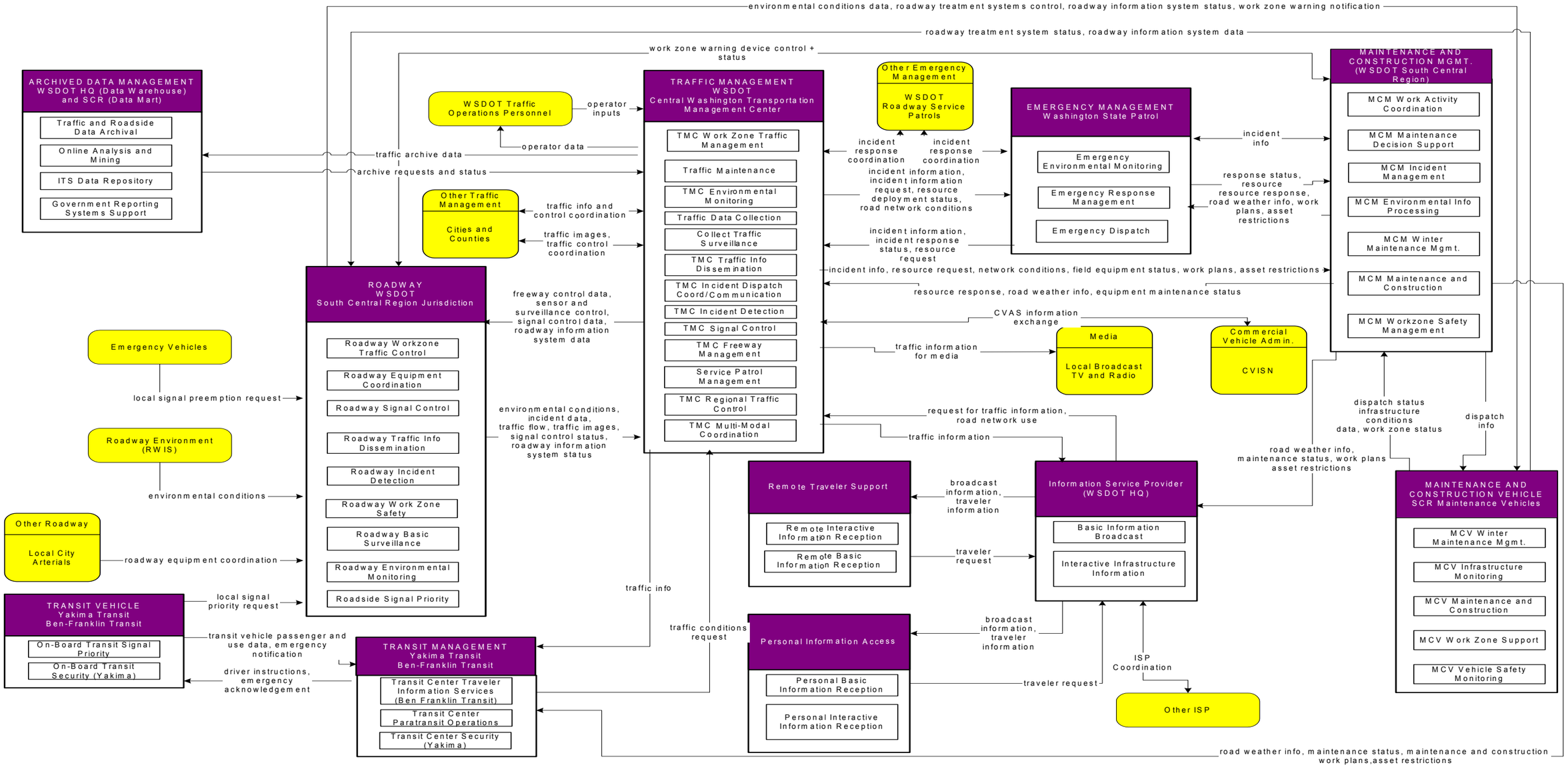
The South Central Washington Regional ITS Architecture uses the National ITS Architecture as a basis for the development of a number of architecture flow diagrams that represent the system functional requirements, interface requirements, and information exchanges for the region. Previous sections of this report have illustrated how the National ITS Architecture can be used to develop an architecture diagram that depicts subsystems, equipment packages, and architecture flows for a given ITS design.

An architecture flow diagram, displayed in Figure 5.1, has been developed for the purpose of illustrating the relationships between WSDOT South Central Region, WSDOT Headquarters, local jurisdictions, transit, and emergency services. The diagram was developed from the perspective of WSDOT, in that it shows those relationships directly impacting WSDOT's statewide or regional operations. It should be noted that the diagram depicts all relationships that are considered possible or desirable based on stakeholder feedback, and includes existing, planned, and "wish list" operations. The architecture flow diagram summarizes the flow of information between each of the entities interfacing directly with WSDOT's South Central Region as well as the interface requirements for each of these entities. The diagram also identifies each of the equipment packages that will be required to meet the system functional requirements for the region. These equipment packages are based upon the market packages that will be deployed for the region. The equipment packages are shown as boxes inside the more major subsystems. The following subsystems have been included, with their roles being as described below:

- **Traffic Management**: This subsystem represents the South Central Region's traffic management operations at the Traffic Management Center. Included are equipment packages for incident detection, traffic surveillance, equipment maintenance, signal control, service patrol management, and collection/dissemination of traffic information. Traffic Management is shown to interact with most of the other subsystems, exchanging traffic data, traffic images, maintenance and work zone data and incident data to the State Patrol, WSDOT Headquarters, Maintenance, Data Management, and Roadway.
- **Maintenance and Construction Management**: This subsystem represents the South Central Region's maintenance department. Equipment packages were selected to indicate all aspects of the department's various maintenance and work zone management duties, encompassing vehicle maintenance, winter roadway maintenance, safety, environmental monitoring, and work zone incident management.
- **Emergency Management**: The Washington State Patrol and WSDOT work closely together to respond to incidents and exchange road conditions data. Via the South Central TMC, WSP officers have direct access to cameras and other equipment.
- **Information Service Provider**: WSDOT headquarters collects and distributes CCTV camera images and traffic information to travelers over its Web site and roadside devices.
- **Maintenance and Construction Vehicle**: Equipment packages for the South Central Region maintenance vehicle subsystem include vehicle monitoring and diagnostics, environmental monitoring, and work zone, safety, and maintenance support. Information is exchanged with Roadside and Maintenance and Construction Management subsystems.

- **Archived Data Management**: Two market packages are represented in part by this subsystem: Data Warehouse and the smaller Data Mart. WSDOT's state-level data warehouse is already in existence, and refers to the statewide collection of traffic data. Regionally, a South Central data mart is not yet in place but may be developed in the future as more advanced traffic management systems are deployed.
- **Roadway**: The Roadway subsystem represents all ITS equipment deployed or to potentially be deployed, roadside in the South Central Region. This includes work zone safety equipment, DMS, speed monitoring equipment, RWIS sensors, traffic signal control, video surveillance, ramp meters, etc.
- **Transit Vehicle**: In this case, the transit vehicle subsystem plays a role primarily for transit signal priority. Transit vehicles in the Tri-Cities have been equipped with TSP emitters. Yakima Transit vehicles have cameras for security.
- **Transit Management**: This subsystem covers the local transit operators in Yakima and the Tri-Cities. Ben Franklin Transit has developed a web site for traveler information. Computer Aided Dispatch for Dial-A-Ride in the Tri-Cities is also included.
- **Personal Information Access and Remote Traveler Support**: These subsystems refer to devices used by the public to access WSDOT traveler information.
- **Terminators**: Terminators are represented by yellow rounded rectangles. These are elements that interact with the South Central systems via data sharing, and include local media, incident response vehicles, the CVISN programs, and local roadway equipment (such as signals in the Tri-Cities or Yakima)

Figure 5.1 – WSDOT South Central Region ITS Architecture



6. IDENTIFICATION OF ITS STANDARDS

ITS standards are paving the way for interoperability and interchangeability of ITS equipment. US DOT maintains an up-to-date summary on the status of ITS standards (http://www.its-standards.net/). This online summary document provides an explanation of key standards and provides additional contact information to obtain more details. However, because ITS standards are under active development, information is being updated regularly at the US DOT website and should be consulted for the latest information. Key standards that will support interoperability are discussed below.

6.1.1 Common Standards

There are a series of standards that define terms, message sets and foundation standards that cut across many market packages. These standards form the basis for interoperability among systems by defining a common set of terms and message sets. Key standards that should be adopted and used by regional jurisdictions in the development of ITS applications include:

- **Data Dictionary for Advanced Traveler Information System (ATIS)**: A minimum set of medium- independent data elements needed by potential information service providers to deploy ATIS services and provide the basis for future interoperability of ATIS devices.
- **Message Set for Advanced Traveler Information System (ATIS)**: A basic message set using the data elements from the ATIS data dictionary needed by potential information service providers to deploy ATIS services and to provide the basis for future interoperability of ATIS devices.
- **Message Sets for External TMC Communication (MS/ ETMCC)**: A message set standard for communication between traffic management centers and other ITS centers, including information service providers, emergency management systems, emissions management systems, and transit management systems.
- **National Location Referencing Information Report**: A basis for location referencing standardization activities by various application communities and Standards Development Organization(s) (SDOs).
- **Standard for Common Incident Management Message Sets (IMMS) for use by EMC**: Standards describing the form and content of the incident management messages sets for emergency management systems (EMS) to traffic management systems (TMS) and from emergency management systems to the emergency telephone system (ETS) or (E911).
- **Standard for Data Dictionaries for Intelligent Transportation Systems**: A set of meta entities and meta attributes for ITS data dictionaries, as well as associated conventions and schemas, that enable describing, standardizing, and managing all ITS data.
- **Standard for Functional Level Traffic Management Data Dictionary (TMDD)**: This document contains data elements for roadway links and for incidents and traffic- disruptive roadway events. It includes data elements for traffic control, ramp metering, traffic modeling, video camera control traffic, parking management and weather forecasting, as well as data elements related to detectors, actuated signal controllers, vehicle probes, and dynamic message signs.

- **Standard for Traffic Incident Management Message Sets for Use by EMCs**: Enables consistent standardized communications among Incident Management Centers, Fleet and Freight Management Centers, Information Service Providers, Emergency Management Centers, Planning Subsystems, Traffic/Transportation Management Centers and Transit Management Centers.

These key baseline standards are critical for the deployment of a wide range of market packages because they establish the common vocabulary that allows different systems to speak with each other.

6.1.2 National Transportation Communications for ITS Protocol

National Transportation Communications for ITS Protocol (NTCIP) provides a suite of communications protocols and data definitions for two different types of ITS communications. The first type is between two transportation management centers (or systems) that is called center-to-center (C2C). The second type is the link from a transportation management system or center to a field device like a traffic signal or dynamic message sign. The second type is call center-to-field (C2F). Additional information on NTCIP standards is found at the following website – http://www.ntcip.org/index.html.

For C2F applications, NTCIP offers the potential for interchangeability and interoperability of equipment from different suppliers on the same system. This family of standards provides both the rules for communicating (called protocols) and the vocabulary (called objects) necessary to allow electronic traffic control equipment from different manufacturers and transportation management centers to operate with each other as a system.[19] Key C2F standards that should be adopted and used by regional jurisdictions are shown in Table 6.1 below**.**

Table 6.1: NTCIP Center-to-Field Standards

NTCIP STANDARD	NAME	DESCRIPTION
NTCIP 1202	Object Definitions for Actuated Traffic Signal Controller Units	Specifications for objects that are specific to actuated signal controllers and definitions of standardized object groups that can be used for conformance statements.
NTCIP 1203	Object Definitions for Dynamic Message Signs	Defines data that is specific to dynamic message signs including all types of signs that can change state, such as blank- out signs, changeable signs, and variable signs.
NTCIP 1204	Object Definitions for Environmental Sensor Stations & Roadside Weather Information System	Definitions of objects that are specific to environmental sensor stations (ESS) and object groups, which can be used for conformance statements.

[19] U.S. Department of Transportation, Intelligent Transportation Systems, Standards Fact Sheet, October 1999, AASHTO/ITE/NEMA TS 3.1, National Transportation Communications for ITS Protocol (NTCIP) Overview

NTCIP STANDARD	NAME	DESCRIPTION
NTCIP 1205	Data Dictionary for Closed Circuit Television (CCTV)	A database for Closed Circuit Television systems. The format of the database is identical to other NTCIP devices and uses ASN. 1 representation. Targeted devices include cameras, lenses, video switches, and positioning controls for aiming and identification, such as videotext overlays.
NTCIP 1206	Data Collection and Monitoring Devices	Specifies object definitions that may be supported by data collection and monitoring devices, such as roadway loop detectors.
NTCIP 1207	Ramp Meter Controller Objects	Specifications for objects that are specific to ramp metering controller operations.
NTCIP 1208	Object Definitions for Video Switches	Deals with the data needed to control a video switch enabling multiple monitors to view multiple video feeds.
NTCIP 1209	Transportation System Sensor Objects	Object definitions that are specific to and guide the data exchange content between advanced sensors and other devices in an NTCIP network. Advanced sensors include video- based detection sensors, inductive loop detectors, sonic detectors, infrared detectors, and microwave/ radar detectors.
NTCIP 1210	Objects for Signal Systems Master	This standard will define the objects necessary to manage a field master.

6.1.3 Transit Communications Interface Profiles

The Institute of Transportation Engineers, with funding from the US Department of Transportation's Joint Program Office for ITS, is managing the Transit Communications Interface Profiles (TCIP) Project. TCIP is a suite of data interface standards for the transit industry (http://www.tcip.org/). This suite of standards includes the wide range of transit ITS applications. A summary of the TCIP standards is found on the website. As other transit ITS applications are considered for implementation, the emerging TCIP standards should be considered.

A compilation of National ITS Standards, mapped to Market Packages, has been assembled for the South Central Region and can be found in Appendix A.

7. SEQUENCE OF PROJECTS REQUIRED FOR IMPLEMENTATION

The South Central Region has deployed a variety of field devices, including CCTV cameras, Dynamic Message Signs, weather sensors, Highway Advisory Radio, and traffic count stations. The Central Washington TMC is responsible for monitoring weather and traffic conditions within the South Central and North Central regions and alerting the public and incident response agencies accordingly, through the region's DMS, HAR, Internet, and radio communications. The South Central Region is currently faced with some field devices integration problems that make it difficult to communicate with all of the HAR and DMS in the region. DMS on I-82, in the Umatilla area, and on Snoqualmie Pass, have been installed with different controllers. DMS on Snoqualmie Pass operate using a system called MIST, which communicates using a non-standard protocol and, as a result, has created operational problems for integrated control within the Central Washington TMC. Thus, the procurement and use of an NTCIP-compliant controller that is accessible from the Central Washington TMC would be of great benefit.

Integration of HAR is also advisable. Currently, the time required to individually update each HAR, as well as inability to simultaneously update several HAR with the same message when desirable, and lack of access to HAR outside of each TMC's own region, is resulting in operations that are less than optimal. It has been proposed that HAR sites statewide become integrated using a networked server system to update the messages.

Integration of these field devices, in accordance with ITS standards, is a key step forward that will be necessary in order to see maximized benefit from the technologies.

8. NEXT STEPS

The WSDOT South Central Region ITS Architecture provides a framework for the deployment of ITS applications. The Architecture incorporates the existing and planned ITS projects and provides a roadmap for future deployment. Additional planning efforts will be required in the future as project initiatives are finalized, expanded or abandoned. The Regional ITS Architecture will need to be updated to reflect these additions.

APPENDIX A

South Central Region Relevant ITS Standards

Standard	Broadcast Traveler Information	Demand Response Transit Operations	Emergency Response	Emergency Routing	Freeway Control	Incident Management System	Interactive Traveler Information	ITS Data Mart	ITS Data Warehouse	Maintenance and Construction Activity Coordi	Maintenance and Construction Vehicle Mainte	Maintenance and Construction Vehicle Tracki	Multi-modal Coordination	Network Surveillance	Regional Traffic Control	Road Weather Data Collection	Roadway Maintenance and Construction	Roadway Service Patrols	Surface Street Control	Transit Security	Traffic Information Dissemination	Transit Traveler Information	Weather Information Processing and Distribut	Winter Maintenance	Work Zone Management	Work Zone Safety Monitoring
A Conceptual ITS Architecture: An ATIS Perspective	x	x				x								x						x	x	x				
Advanced Traveler Information System (ATIS) Data Dictionary	x			x		x	x		x					x							x					
Advanced Traveler Information System (ATIS) Message Set	x			x		x	x		x					x							x					
Data Dictionary for Advanced Traveler Information System (ATIS)	x					x	x							x							x	x				
ISP-Vehicle Location Referencing Message Profiles	x						x																			
ISP-Vehicle Location Referencing Standard	x						x																			
ITS In-Vehicle Message Priority	x						x																			
Measurement of Driver Visual Behavior Using Video Based Methods (Def. & Meas.)	x						x																			
Message Set for Advanced Traveler Information System (ATIS)	x	x				x	x							x						x	x	x				
Message Set for External TMC Communication (MS/ETMCC)	x	x	x	x	x	x	x	x	x				x	x	x		x		x	x	x	x		x		
Messages for Handling Strings and Look-Up Tables in ATIS Standards	x	x				x	x							x						x	x	x				
NTCIP - Application Profile for Common Object Request Broker Architecture (CORBA)	x	x		x		x	x	x	x		x			x	x	x	x			x	x	x	x		x	
NTCIP - Application Profile for File Transfer Protocol (FTP)	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x	x
NTCIP - Application Profile for Simple Transportation Management Framework	x	x	x	x	x	x	x		x				x	x	x	x			x	x	x	x			x	x
NTCIP - Application Profile for Trivial File Transfer Protocol	x	x	x	x	x	x	x	x	x				x	x	x	x			x	x	x	x			x	
NTCIP - Applications Profile for Common Object Request Broker Architecture	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x	
NTCIP - Applications Profile for Data Exchange ASN.1 (DATEX)	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	x	x	x	x	x	x	
NTCIP - Base Standard: Octet Encoding Rules (OER)	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	
NTCIP - Class A and Class C Communications Profiles				x	x	x		x	x				x	x	x				x		x					
NTCIP - Class B Profile				x	x	x		x	x				x	x	x	x			x		x				x	x

Standard	Broadcast Traveler Information	Demand Response Transit Operations	Emergency Response	Emergency Routing	Freeway Control	Incident Management System	Interactive Traveler Information	ITS Data Mart	ITS Data Warehouse	Maintenance and Construction Activity Coordi	Maintenance and Construction Vehicle Mainte	Maintenance and Construction Vehicle Tracki	Multi-modal Coordination	Network Surveillance	Regional Traffic Control	Road Weather Data Collection	Roadway Maintenance and Construction	Roadway Service Patrols	Surface Street Control	Transit Security	Traffic Information Dissemination	Transit Traveler Information	Weather Information Processing and Distribut	Winter Maintenance	Work Zone Management	Work Zone Safety Monitoring
NTCIP - CORBA Near Real Time Data Service	x	x	x	x		x	x	x	x	x				x	x	x		x		x	x	x	x	x	x	
NTCIP - CORBA Naming Convention	x	x	x	x		x	x	x		x				x		x	x			x	x	x	x	x	x	
NTCIP - CORBA Security Service	x	x	x	x		x	x	x	x	x				x	x	x	x	x		x	x	x	x	x	x	
NTCIP - Data Collection & Monitoring Devices					x	x		x	x					x	x				x							
NTCIP - Data Dictionary for Closed Circuit Television (CCTV)					x	x								x					x		x				x	
NTCIP - Global Object Definitions			x		x								x		x	x			x		x				x	
NTCIP - Information Profile for CORBA	x	x	x	x		x	x	x	x	x				x	x	x	x	x		x	x	x	x	x	x	
NTCIP - Information Profile for DATEX	x	x	x	x		x	x	x	x	x				x	x	x	x	x		x	x	x	x	x	x	
NTCIP - Internet (TCP/IP and UDP/IP) Transport Profile	x		x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x		x	x	x	x
NTCIP - Message Set for Weather Reports	x		x	x			x							x			x				x	x		x		
NTCIP - Object Definitions for Actuated Traffic Signal Controller Units				x	x								x	x	x				x						x	
NTCIP - Object Definitions for Dynamic Message Signs					x																x				x	
NTCIP - Object Definitions for Environmental Sensor Stations & Roadside Weather Information System	x				x		x	x	x					x					x						x	
NTCIP - Object Definitions for Video Switches						x								x					x						x	
NTCIP - Objects for Signal Control Priority				x									x		x				x							
NTCIP - Objects for Signal Systems Master				x									x		x				x							
NTCIP - Point to Multi-Point Protocol Using RS-232 Subnetwork Profile				x											x	x									x	x
NTCIP - Profiles - Framework and Classification of Profiles					x	x								x	x				x		x					
NTCIP - Ramp Meter Controller Objects					x									x	x				x							
NTCIP - Simple Transportation Management Framework (STMF)	x	x	x	x	x	x	x	x	x				x	x	x	x			x	x	x	x			x	x
NTCIP - Simple Transportation Management Protocol				x		x		x					x	x	x	x			x		x				x	x
NTCIP - Subnet Profile for Ethernet	x	x	x	x		x		x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	
NTCIP - Subnet Profile for Point-to-Point Protocol using RS 232				x		x		x					x	x	x	x			x		x				x	x
NTCIP - Subnet Profile for PMPP Over FSK modems				x		x			x				x	x	x	x			x		x				x	x

Standard	Broadcast Traveler Information	Demand Response Transit Operations	Emergency Response	Emergency Routing	Freeway Control	Incident Management System	Interactive Traveler Information	ITS Data Mart	ITS Data Warehouse	Maintenance and Construction Activity Coordi	Maintenance and Construction Vehicle Mainte	Maintenance and Construction Vehicle Tracki	Multi-modal Coordination	Network Surveillance	Regional Traffic Control	Road Weather Data Collection	Roadway Maintenance and Construction	Roadway Service Patrols	Surface Street Control	Transit Security	Traffic Information Dissemination	Transit Traveler Information	Weather Information Processing and Distribut	Winter Maintenance	Work Zone Management	Work Zone Safety Monitoring
NTCIP - Transportation System Sensor Objects					x	x		x	x					x	x				x							
NTCIP - Transportation Transport Profile				x		x			x				x	x	x				x		x				x	x
Specification for Dedicated Short Range Communication (DSRC) Physical Layer using Microwave in the 902-928 MHz				x									x													
Standard for ATIS Message Sets Delivered Over Bandwidth Restricted Media	x						x																			
Standard for Common Incident Management Message Sets (IMMS) for use by EMCs	x	x	x	x		x	x	x	x					x			x	x	x	x	x	x		x		
Standard for Emergency Management Data Dictionary			x			x											x	x						x		
Standard for Functional Level Traffic Management Data Dictionary (TMDD)	x	x	x	x	x	x	x	x	x				x	x	x		x		x	x	x	x		x		
Standard for Hazardous Material IMMS for use by EMCs			x			x																				
Standard for Message Sets for Vehicle/Roadside Communications																										x
Standard for Public Safety IMMS for use by EMCs			x			x																				
Standard for Traffic Incident Management Message Sets for Use by EMCs			x			x											x	x						x		
Standard Specification for 5.9 GHz Physical Layer				x									x			x										x
Standard Specification for 5.9 GHz Data Link Layer				x									x			x										x
Standard Specification for DSRC - Data Link Layer				x																						
Standard Specification for DSRC - Physical Layer 902-928 MHz				x																						
Subcarrier Traffic Information Channel (STIC) System	x																									
TCIP - Common Public Transportation (CPT) Business Area Standard		x											x							x		x				
TCIP - Control Center (CC) Business Area Standard		x					x	x	x				x									x				
TCIP - Fare Collection (FC) Business Area Standard							x		x																	

Standard	Broadcast Traveler Information	Demand Response Transit Operations	Emergency Response	Emergency Routing	Freeway Control	Incident Management System	Interactive Traveler Information	ITS Data Mart	ITS Data Warehouse	Maintenance and Construction Activity Coordi	Maintenance and Construction Vehicle Mainte	Maintenance and Construction Vehicle Tracki	Multi-modal Coordination	Network Surveillance	Regional Traffic Control	Road Weather Data Collection	Roadway Maintenance and Construction	Roadway Service Patrols	Surface Street Control	Transit Security	Traffic Information Dissemination	Transit Traveler Information	Weather Information Processing and Distribut	Winter Maintenance	Work Zone Management	Work Zone Safety Monitoring
TCIP - Framework Document		x											x							x		x				
TCIP - Incident Management (IM) Business Area Standard	x		x			x	x																			
TCIP - Onboard (OB) Business Area Standard		x											x							x						
TCIP - Passenger Information (PI) Business Area Standard	x	x					x													x		x				
TCIP - Scheduling/Runcutting (SCH) Business Area Standard	x	x					x													x		x				
TCIP - Spatial Representation (SP) Business Area Standard		x											x							x		x				
TCIP - Traffic Management (TM) Business Area Standard		x											x													

APPENDIX B

National ITS Architecture Definitions

APPENDIX B: NATIONAL ITS ARCHITECTURE DEFINITIONS

MARKET PACKAGES[20]

ITS Data Mart: This market package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use. It provides the basic data quality, data privacy, and meta data management common to all ITS archives and provides general query and report access to archive data users.

ITS Data Warehouse: This market package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this market package in addition to the basic query and reporting user access features offered by the ITS Data Mart.

Transit Vehicle Tracking: This market package provides for an Automated Vehicle Location System to track the transit vehicle's real time schedule adherence and updates the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. Fixed route transit systems may also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the Information Service Provider Subsystem via a wireline link.

Transit Fixed-Route Operations: This market package performs automatic driver assignment and monitoring, as well as vehicle routing and scheduling for fixed-route services. This service uses the existing AVL database as a source for current schedule performance data, and is implemented through data processing and information display at the transit management subsystem. This data is exchanged using the existing wireline link to the information service provider where it is integrated with that from other transportation modes (e.g., rail, ferry, air) to provide the public with integrated and personalized dynamic schedules

Demand Response Transit Operations: This market package performs automatic driver assignment and monitoring as well as vehicle routing and scheduling for demand response transit services. This package uses the existing AVL database to monitor current status of the transit fleet and supports

[20] These Market Package definitions are given for all of the Market Packages developed for Version 4.0 of the National ITS Architecture. Further information, including definitions of subsystems and equipment packages are available at http://www.odetics.com/itsarch.

allocation of these fleet resources to service incoming requests for transit service while also considering traffic conditions. The Transit Management Subsystem provides the necessary data processing and information display to assist the transit operator in making optimal use of the transit fleet. The Information Service Provider Subsystem may be either be operated by transit management center or be independently owned and operated by a separate service provider. In the first scenario, the traveler makes a direct request to a specific paratransit service. In the second scenario, a third party service provider determines the paratransit service is a viable means of satisfying a traveler request and uses wireline communications to make a reservation for the traveler.

Transit Passenger and Fare Management: This market package allows for the management of passenger loading and fare payments on-board vehicles using electronic means. The payment instrument may be either a stored value or credit card. This package is implemented with sensors mounted on the vehicle to permit the driver and central operations to determine vehicle loads, and readers located either in the infrastructure or on-board the transit vehicle to allow fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem using existing wireless infrastructure.

Transit Security: This market package provides for the physical security of transit passengers. An on-board security system is deployed to perform surveillance and warn of potentially hazardous situations. Public areas (e.g., stops, park and ride lots, stations) are also monitored. Information is communicated to the Transit Management Subsystem using the existing or emerging wireless (vehicle to center) or wireline (area to center) infrastructure. Security related information is also transmitted to the Emergency Management Subsystem when an emergency is identified that requires an external response. Incident information is communicated to the Information Service Provider.

Transit Maintenance: This market package supports automatic maintenance scheduling and monitoring. On-board condition sensors monitor critical system status and transmit critical status information to the Transit Management Subsystem. Hardware and software in the Transit Management Subsystem processes this data and schedules maintenance activities.

Multi-Modal Coordination: This market package establishes two way communications between multiple transit and traffic agencies to improve service coordination. Intermodal coordination between transit agencies can increase traveler convenience at transfer points and also improve operating efficiency. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network. More limited local coordination between the transit vehicle and the individual intersection for signal priority is also supported by this package.

Transit Traveler Information: This market package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop annunciation, imminent arrival signs, and real-time transit schedule displays that are of general interest to transit users. Systems that provide custom transit trip itineraries and other tailored transit information services are also represented by this market package.

Broadcast Traveler Information: This market package provides the user with a basic set of ATIS services; its objective is early acceptance. It involves the collection of traffic conditions, advisories, general public transportation, toll and parking information, incident information, air quality and weather

information, and the near real time dissemination of this information over a wide area through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). Different from the market package ATMS6--Traffic Information Dissemination--which provides the more basic HAR and DMS information capabilities, ATIS1 provides the more sophisticated digital broadcast service. Successful deployment of this market package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.

Interactive Traveler Information: This market package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, transit services, ride share/ride match, parking management, and pricing information. A range of two-way wide-area wireless and wireline communications systems may be used to support the required digital communications between traveler and the information service provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en-route to include phone, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. Successful deployment of this market package relies on availability of real-time transportation data from roadway instrumentation, probe vehicles or other means.

Network Surveillance: This market package includes traffic detectors, other surveillance equipment, the supporting field equipment, and wireline communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this market package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.

Probe Surveillance: This market package provides an alternative approach for surveillance of the roadway network. Two general implementation paths are supported by this market package: 1) wide-area wireless communications between the vehicle and Information Service Provider is used to communicate current vehicle location and status, and 2) dedicated short range communications between the vehicle and roadside is used to provide equivalent information back to the Traffic Management Subsystem. The first approach leverages wide area communications equipment that may already be in the vehicle to support personal safety and advanced traveler information services. The second approach utilizes vehicle equipment that supports toll collection, in-vehicle signing, and other short range communications applications identified within the architecture. The market package enables traffic managers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. It requires one of the communications options identified above, roadside beacons and wireline communications for the short range communications option, data reduction software, and utilizes wireline links between the Traffic Management Subsystem and Information Service Provider Subsystem to share the collected information. Both “Opt out” and “Opt in” strategies are available to ensure the user has the ability to turn off the probe functions to ensure individual privacy. Due to the large volume of data collected by probes, data reduction techniques are required in this market package which include the ability to identify and filter out-of-bounds or extreme data reports.

Surface Street Control: This market package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this market package ranging from static pre-timed control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. Additionally, general advisory and traffic control information can be provided to the driver while en-route. This market package is generally an intra-jurisdictional package that does not rely on real-time communications between separate control systems to achieve area-wide traffic signal coordination. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would be represented by this package. This market package is consistent with typical urban traffic signal control systems.

Freeway Control: This market package provides the communications and roadside equipment to support ramp control, lane controls, and interchange control for freeways. Coordination and integration of ramp meters are included as part of this market package. This package is consistent with typical urban traffic freeway control systems. This package incorporates the instrumentation included in the Network Surveillance Market Package to support freeway monitoring and adaptive strategies as an option.

This market package also includes the capability to utilize surveillance information for detection of incidents. Typically, the processing would be performed at a traffic management center; however, developments might allow for point detection with roadway equipment. For example, a CCTV might include the capability to detect an incident based upon image changes. Additionally, this market package allows general advisory and traffic control information to be provided to the driver while en-route.

Traffic Information Dissemination: This market package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as dynamic message signs or highway advisory radio. This package provides a tool that can be used to notify drivers of incidents; careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), transit management center, emergency management center, and information service provider.

Regional Traffic Control: This market package advances the Surface Street Control and Freeway Control Market Packages by adding the communications links and integrated control strategies that enable integrated Interjurisdictional traffic control. This market package provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Market Packages and adds hardware, software, and wireline communications capabilities to implement traffic management strategies which are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of control between traffic management centers.

Incident Management System: This market package manages both predicted and unexpected incidents so that the impact to the transportation network and traveler safety is minimized. Requisite incident

detection capabilities are included in the freeway control market package and through the regional coordination with other traffic management and emergency management centers, weather service entities, and event promoters supported by this market package. Information from these diverse sources are collected and correlated by this market package to detect and verify incidents and implement an appropriate response. This market package provides Traffic Management Subsystem equipment that supports traffic operations personnel in developing an appropriate response in coordination with emergency management and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications and presentation of information to affected travelers using the Traffic Information Dissemination market package. The same equipment assists the operator by monitoring incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other field service personnel.

Parking Facility Management: This market package provides enhanced monitoring and management of parking facilities. The included equipment assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This is performed by sensing and collecting current parking facilities status, sharing the data with information service providers and traffic operations, and automatic fee collection using short range communications with the same in-vehicle equipment utilized for electronic toll collection.

Speed Monitoring: This market package monitors the speeds of vehicles traveling through a roadway system. If the speed is determine to be excessive, roadside equipment can suggest a safe driving speed. Environmental conditions may be monitored and factored into the safe speed advisories that are provided to the motorist. This service can also support notifications to an enforcement agency to enforce the speed limit on a roadway system.

Fleet Administration: This market package keeps track of vehicle location, itineraries, and fuel usage at the Fleet and Freight Management Subsystem using a cell based or satellite data link and the pre-existing wireless infrastructure. The vehicle has a processor to interface to its sensor (e.g., fuel gauge) and to the cellular data link. The Fleet and Freight Management Subsystem can provide the vehicle with dispatch instructions, and can process and respond to requests for assistance and general information from the vehicle via the cellular data link. The market package also provides the Fleet Manager with connectivity to intermodal transportation providers using the existing wireline infrastructure.

Freight Administration: This market package tracks cargo and the cargo condition. This information is communicated with the Fleet and Freight Management Subsystem via the existing wireless infrastructure. Interconnections are provided to intermodal shippers and intermodal freight depots for tracking the cargo from source to destination.

Electronic Clearance: This market package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem over wireline to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This package allows a good driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated short range communications to the roadside. The roadside check facility may be equipped with AVI, weighing sensors, transponder read/write devices, computer workstation processing hardware, software, and databases.

CV Administrative Processes: This market package provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in the electronic clearance program provided by a separate market package which allows commercial vehicles to be screened at mainline speeds at commercial vehicle check points. Through this enrollment process, current profile databases are maintained in the Commercial Vehicle Administration Subsystem and snapshots of this database are made available to the commercial vehicle check facilities at the roadside to support the electronic clearance process.

International Border Electronic Clearance: This market package provides for automated clearance specific to international border crossings. This package augments the electronic clearance package by allowing interface with customs related functions and permitting NAFTA required entry and exit from the US to Canada and Mexico.

Weigh-In-Motion: This market package provides for high speed weigh-in-motion with or without AVI attachment. Primarily this market package provides the roadside with additional equipment, either fixed or removable. If the equipment is fixed, then it is thought to be an addition to the electronic clearance and would work in conjunction with the AVI and AVC equipment in place.

Roadside CVO Safety: This market package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the Commercial Vehicle Check roadside element. The capabilities for performing the safety inspection are shared between this market package and the On-Board CVO Safety Market Package which enables a variety of implementation options. The basic option, directly supported by this market package, facilitates safety inspection of vehicles that have been pulled in, perhaps as a result of the automated screening process provided by the Electronic Clearance Market Package. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-Board CVO Safety market package, utilize additional vehicle safety monitoring and reporting capabilities in the commercial vehicle to augment the roadside safety check.

On-Board CVO Safety: This market package provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety Market Package and includes roadside support for reading on-board safety data via tags. This market package uses the same communication links as the Roadside CVO Safety Market Package, and provides the commercial vehicle with a wireless link (data and possibly voice) to the Fleet and Freight Management and the Emergency Management Subsystems. Safety warnings are provided to the driver as a priority with secondary requirements to notify the Fleet and Freight Management and Commercial Vehicle Check roadside elements.

CVO Fleet Maintenance: This market package supports maintenance of CVO fleet vehicles through close interface with on-board monitoring equipment and AVLS capabilities with in the Fleet and Freight Management Subsystem. Records of vehicle mileage, repairs, and safety violations are maintained to assure safe vehicles on the highway.

HAZMAT Management: This market package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.

Emergency Response: This market package provides the computer-aided dispatch systems, emergency vehicle equipment, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Subsystems supports emergency notification and coordinated response between agencies. Existing wide area wireless communications would be utilized between the Emergency Management Subsystem and an Emergency Vehicle to enable an incident command system to be established and supported at the emergency location. The Emergency Management Subsystem would include hardware and software for tracking the emergency vehicles. Public safety, traffic management, and many other allied agencies may each participate in the coordinated response managed by this package.

Emergency Routing: This market package supports dynamic routing of emergency vehicles and coordination with the Traffic Management Subsystem for special priority on the selected route(s). The Information Service Provider Subsystem supports routing for the emergency fleet based on real-time traffic conditions and the emergency routes assigned to other responding vehicles. In this market package, the Information Service Provider Subsystem would typically be integrated with the Emergency Management Subsystem in a public safety communications center. The Emergency Vehicle would also optionally be equipped with dedicated short-range communications for local signal preemption.

Mayday Support: This package allows the user (driver or non-driver) to initiate a request for emergency assistance and enables the Emergency Management Subsystem to locate the user and determine the appropriate response. The Emergency Management Subsystem may be operated by the public sector or by a private sector provider. The request from the traveler needing assistance may be manually initiated or automated and linked to vehicle sensors. The data is sent to the Emergency Management subsystem using wide area wireless communications with voice as an option. Providing user location implies either a location technology within the user device or location determination within the communications infrastructure.

Roadway Service Patrols: This market package supports roadway service patrol vehicles that monitor roads that typically have incidents, offering rapid response to minor incidents (flat tire, accidents, out of gas) to minimize disruption to the traffic stream. If problems are detected, the roadway service patrol vehicles will provide assistance to the motorist (e.g., push a vehicle to the shoulder or median).

Maintenance and Construction Vehicle Tracking: This market package will track the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities. These activities can include ensuring the correct roads are being plowed and work activity is being performed at the correct locations.

Maintenance and Construction Vehicle Maintenance: This market package performs vehicle maintenance scheduling and manages both routine and corrective maintenance activities on vehicles and other maintenance and construction equipment. It includes on-board sensors capable of automatically performing diagnostics for maintenance and construction vehicles, and the systems that collect this diagnostic information and use it to schedule and manage vehicle maintenance.

Road Weather Data Collection: This market package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. In addition to fixed sensor stations at the roadside, sensing of the roadway environment can also occur from sensor systems located on Maintenance and Construction Vehicles. The collected environmental data is used by the Weather Information Processing and Distribution Market Package to process the information and make decisions on operations.

Weather Information Processing and Distribution: This market package processes and distributes the environmental information collected from the Road Weather Data Collection market package. This market package uses the environmental data to detect environmental hazards such as icy road conditions, high winds, dense fog, etc. so system operators and decision support systems can make decision on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination market package, and aid operators in scheduling work activity.

Winter Maintenance: This market package supports winter road maintenance including snowplow operations, roadway treatments (e.g., salt spraying and other anti-icing material applications), and other snow and ice control activities. This package monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response, and track and manage response operations.

Roadway Maintenance and Construction: This market package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way. Maintenance services would include landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non-ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, CCTV, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling maintenance and construction activities.

Work Zone Management: This market package directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds and delays are provided to the motorist prior to the work zones.

Work Zone Safety Monitoring: This market package includes systems that improve work crew safety and reduce collisions between the motoring public and maintenance and construction vehicles. This market package detects vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment or other potential safety hazards. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone. The market package supports both stationary and mobile work zones.

Maintenance and Construction Activity Coordination: This market package supports the dissemination of maintenance and construction activity to centers, which can utilize it as part of their operations, or to Information Service Providers who can provide the information to travelers